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MARCH, 1905

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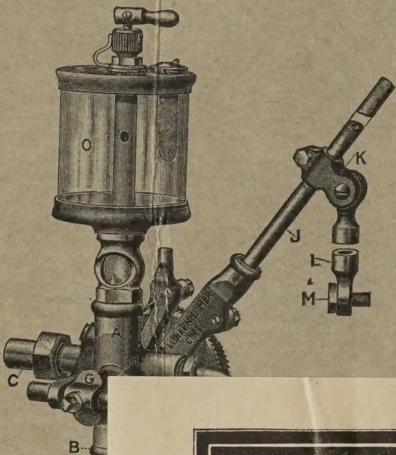

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GEOLOGY OF THE MISSISSIPPI EMBAYMENT.

Contributed by Maj. T. G. Dabney, Chief Engineer, Yazoo-Mississippi Delta Levee District, Clarksdale, Miss.

Mississippi embayment is the designation given by geologists to what is commonly called the "Mississippi Delta," the term "Delta" being a misnomer as applied now to any part of this region except that which is adjacent to the present mouths of the Mississippi River. The name delta was probably applicable to all of the "alluvial" region lying below the mouth of Red River at one period of the river's history, but the delta proper was long ago pushed down to the rivers' present mouths or their vicinity.

The term Mississippi embayment, as used by geologists, embraces all of the territory known as the "alluvial valley" of the lower Mississippi bounded by the uplands on the east and west and extending from about thirty miles above Cairo to the Gulf of Mexico.

The term "alluvial valley" is also a misnomer as applied to the major part of this territory, as in reality but a small proportion of it is truly alluvial in character.

It is a very general belief, entertained by nearly all persons who are brought to contemplate the subject with any degree of interest, that the region under discussion is really alluvial throughout its whole extent, and that the Mississippi River as it now exists, and as we know it, is the agency by which all the material that now fills the Mississippi embayment was brought down from the regions north of here and deposited in the position which it now occupies. The assumption has been that this process of bringing down alluvial matter from the northern hill countries by the Mississippi River, and the spreading of it over the surface of the so-called alluvial valley by the annual overflows, has been going on uninterruptedly from the earliest

history of the Mississippi valley down to the present time, except where interference by the hand of man has arrested the process by preventing the escape of the flood water from the channel, through the medium of levee building.

As a logical deduction from the above premise, it was assumed that a general work of land building has been in constant progress over the whole superficies of the valley, every part thereof being gradually raised to higher elevations, and the river's bed itself, being a participant factor in the general process was being raised *pari passu* with the elevation of the land.

As a further logical deduction from the aforesaid premise, it has been maintained by no less an autohrity than Prof. L. E. Haupt, among others, that the prevention of the distribution of this alluvial matter over the land by the interposition of levees must necessarily result in its deposition within the river's channel, and the speedy filling up thereof.

It is the purpose of this paper to show that the above assumed premise, with all of the deductions logically based thereon, is fundamentally wrong, superficial, and unscientific, and that this basic error has been the ground work of wild misconceptions as to the nature of the problem of controlling the floods of the Mississippi River, as well as the proper solution of this problem.

The crux of the matter, then, is this: Is the material that occupies the Mississippi embayment really alluvial in its character and placed where it is by the Mississippi River as we now know it, or must we look for other causes to account for its existence here?

The writer, from his own observations of the flood phenomena that are common to all observant eyes, had reached the conclusion that either the Mississippi river is not responsible for the bulk of the so-called alluvial material that we find here, or else that the quantity now being brought down by the river is reduced to small proportions, and the process of deposition diminished in vigor very nearly to the point of suspension.

After reaching this conclusion, some forgotten literature on the subject was overhauled and examined, the result of which is here given.

In the report of the Mississippi River Commission for 1882, on pages 205 *et sequentes,* is printed a paper as Appendix P, with the caption, "Report on the Blue Clay of the Mississippi River, by George Little, Ph. D.," the date of which is July 4, 1880.

Prof Little calls his work a "Study and Report on the So-Called Blue Clay Problem of the Mississippi River," and states

the special question to be: "Is this formation one antedating geologically the present river, and into which the river has dug a bed; or is it a deposit by the river itself, in which has formed its own bed, as in the case of 'the Passes?'"

Prof. Little appears to have examined all of the literature on the subject that was extant at that time, and cites a great number of authorities, even including Capt. John Cowden, and Dr. W. J. Carroll, of Natchez, Miss.

Extended quotations are made, from Prof Tuomey, of Alabama, and G. C. Swallow, of Missouri, on the "southern drift," and formations in those States which are the analogues of similar materials in the Mississippi embayment; also Prof. Wailes, Dr. E. W. Hilgard and Dr. E. A. Smith, of Mississippi, and Prof. Hopkins, of Louisiana.

Prof. Little's report thus presents a valuable array of geological authorities on this interesting subject, the various phases of which as discussed by these learned professors, involve so many complications of "periods of depression" and "upheavals," of "denudation" and "refilling," as to leave the mind in a state of more or less confusion after a careful perusal of the whole discussion, regarding the true sequence of these various oscillations of surface.

The preponderance of authorities quoted support the view that the great bulk of material now occupying the basin of the lower Mississippi is of an age that antedates the "modern alluvium" formation, and that the present surface area is composed, over nearly the whole extent, of the "Port Hudson clay," or "buckshot," through which the present river has cut its channel, down into the "drift" and underlying tertiary strata, with only a narrow margin of alluvium of moderate depth along the banks of the main river, its tributaries and bayous, except where old channels have been filled to a greater depth.

Dr. F. V. Hopkins, of Louisiana, adopted the conclusion that the river alluvium is 70 to 100 feet deep, from Baton Rouge to the Arkansas line, based upon a chemical analysis of the water found in tube wells in that region, in which he found "an excess of chlorides," being characteristic of the alluvium and not of the Port Hudson clay. This seeems to have been the sole ground of his conclusion. Dr. Hopkins is thus quoted: "On a trip that I took from Baton Rouge to the Arkansas line, I analyzed the water from various wells of from 70 to 100 feet in depth, and in not a single instance found any other than the alluvial characteristics. The alluvium, then, upon the upper part of the river

being deeper, as a rule, than from 70 to 100 feet, it is highly improbable that it is no deeper than 31 feet at the city of New Orleans.

"It is true that the artesian well passed at that depth from swamp deposits into marine; the question to be decided is whether such a change is in this case a passage from one geological formation into another.

"It is not necessarily so. The term alluvium is, indeed, so generally confined to river formations that we are apt to forget that these are but a small part of the strata that are forming in the present era. The fine blue clay of the Mediterranean, the chalk of the 'Telegraphic Plateau' of the North Atlantic, and the deposits now settling in the Gulf of Mexico from the long brown line projected into it by the mighty Mississippi, are but marine equivalents of the alluvium proper."

The question now being considered is not one of terminology nor of character of material, but of the time when and means by which this material was deposited, whether by the present Mississippi river by a process now going on or by agencies of greater potency antedating the present period.

Prof. Little adopts the conclusion of Dr. Hopkins, to the exclusion of the testimony of all the other authorities quoted, and thus expresses himself:

"The observations of Dr. Hopkins were continued for years over the whole of Louisiana, and his deductions seem to accord more nearly with the facts, certainly as to the thickness of the alluvium, which, as far as I have seen, with a few exceptions, to be mentioned hereafter, is not less than 100 feet thick along the bank of the river from Memphis to New Orleans, as can be readily seen in a hundred places where the levees have been built, and in a few years have caved into the river, frequently as on the Atchafalaya near Simmsport, acres of land having disappeared at once, leaving a vertical wall 100 feet deep, from the bottom of which trees and logs that had been buried for ages were uncovered."

Prof. Little seems extravagant in his expression of the depth of his "vertical wall," as it would be difficult to find such an exposure as much as 40 feet deep, with "trees and logs" uncovered at the bottom of it.

He seems also to have determined at a glance a question that has engaged the patient study of other geologists, that the material in his vertical wall was alluvium.

On the other hand, there is an array of authorities *per contra* quoted by Prof. Little.

Gen. A. A. Humphreys is quoted as saying "(in his Report on the Mississippi River, page 99)" that "the river flows, even in the delta region, in a channel belonging to a geological epoch antecedent to the present." (The above reference should be page 92 instead of 99.)

The report of Humphreys and Abbott further says that "Port Hudson clay" underlies the whole Yazoo basin, the age of which is assigned to the eocene or cretaceous, which is more remote than that assigned by other authorities as the result of a closer study of its character and relations to other strata.

Dr. E. W. Hilgard, who made a very full and thorough study of the geology of Mississippi, is thus quoted in part:

"Having discussed this formation (the Port Hudson clay) somewhat in detail in papers recently published, I will merely state that it embraces a group of partly littoral and estuarian, partly swamp, lagoon, and fluviatile deposits whose thickness and location are manifestly dependent upon the topographical features of the continent, then (during the Champlain period) in progress of slow depression, as shown by the nature of the deposits and the numerous superimposed generations of large cypress stumps imbedded in laminated clays exhibiting the yearly fall of leaves.

"These beds overlie those of the orange sand, or stratified drift, while they themselves are overlaid by, not only the river alluvium, but also by the loess, or bluff silt, or its equivalents, as well as where this is absent by the yellow loam of the surface. It would seem that here also, during the latter part of the drift period, most of the larger river channels were already impressed upon the surface, though not always coincident with the present immediate valley, as Newberry has observed in relation to some of the northern rivers. A depression of the land would gradually transform these channels into inlets filled with more or less stagnant fresh water down to a greater or less distance from the then existing coast line, and thus opportunity would be afforded for the formation of the swamp and lagoon deposits into which both the Mississippi and Red Rivers have subsequently cut their channels. The banks of the Red River as well as, outside the present alluvial area, those of the many lakes and bayous which border that stream, exhibit strata absolutely identical in character with those observed near the coast, yet, of course, totally different from the alluvial deposits of the present time or of the adjoining tertiaries. The same holds true, more or less, of the Mississippi

and its mighty bayous. According to the observations of Dr. E. A. Smith in the Yazoo bottom, and my own in that of the Tensas, not only do the clays with calcareous concretions(as characteristic of the Port Hudson age as they are foreign to the alluvium of today) frequently crop out in the beds of the streams, but much of the best lands of the 'buckshot' kind, now situated above overflow, have clearly been formed by simple disintegration of these strata, altogether independently of the river alluvium.

"These results fully confirm, therefore, the statement made by Gen. Humphreys, that the Mississippi does not, as a rule, flow in a bed formed by its own deposits, but has excavated it in an older geological formation."

Dr. E. A. Smith, assistant in the Mississippi geological survey, is quoted in part as follows:

"Dr. Hilgard remarks (American Journal of Science, January, 1869): 'The stumps stratum No. 1 (Port Hudson profile), however, as appears from numerous data collected by myself or contained in Humphrey's and Abbott's Report, exists at about the same level (i. e., near that of tidal water), not only over all the so-called delta plain of the Mississippi, but also higher up, perhaps, as far as Memphis.'

"Observations made by myself in the Yazoo bottom during the last year led to the conclusion that the true river deposits of any considerable thickness are mostly confined to narrow strips of land on each side of the Mississippi, and of the bayous and creeks that form a network of streams throughout the bottom, and to ancient channels since filled up, while a large proportion of the superficial area of the bottom, including some of the most fertile lands, is derived from the clays of older formations into which the beds of these streams have been excavated."

Again: "The clays of the 'back land,' doubtless belong, for the greater part, to the Port Hudson age, as is indicated by the abundance of ferruginous and calcareous concretions found in them, unlike any found in the true river alluvium, as well as by the great thickness of continuous clay deposits."

In 1880 Mr. E. H. Wilson, United States Assistant Engineer, was employed by Capt. Smith S. Leach, United States Engineer, to make a series of deep borings along the Mississippi River, from Memphis to Hays Landing, Miss., which is six miles below Lake Providence, La., for the purpose of disclosing the nature of the strata encountered. (Report of Mississippi River Commission for 1881, pages 139 *et sequentes.*)

By Mr. Wilson's interpretation, the marine tertiary was

reached at depths varying from 90 feet at Greenville, to 162 feet at Helena. Everything above that plane was denominated by him "alluvium." But Mr. Wilson says (page 143): "The remains of vegetation in the clays near the surface indicates that the formation was certainly not built up as is the modern alluvion, and subsequently elevated by earthquake action.

"To some fluviatile agency more powerful than that of the modern Mississippi, however, must this unique formation be attributed.

"Prof. Potter, of Washington University, has suggested, as a result of considerable study on the subject, that these high prairies were the sand bars of the glacial stream."

Specimens of Mr. Wilson's borings were submitted to Dr. E. W. Hilgard and Dr. F. V. Hopkins, those gentlemen then being located in California. Their report on the examination of the borings is printed in the Report of the Mississippi River Commission for 1883, pages 479 *et sequentes,* from which the following extracts are taken:

"Bottom Borings.

"In all the deeper bottom borings save one (viz: No. 2, Lake Providence), three distinct formations have been penetrated, viz., the river alluvium or its equivalent in time, the equivalents of the Port Hudson beds, and the eocene tertiary strata.

"Much speculation has been indulged in heretofore as to the average depth of the alluvial deposits of the Mississippi, and the results of my observations in the Delta, which seemed to indicate that the deposits of the modern river are comparatively shallow even there, have been repeatedly called in question. The present investigation throws much light on this subject, and likewise rectifies the interpretation of the age of the 'bottom gravel,' which has long been known to underlie the great bottom, but was by myself conjectured to be, in the main, the representative of the 'orange sand' of the uplands. Mr. Wilson correctly concludes, from the constant occurrence through these gravels of lignite grains or 'wash,' that they are not an equivalent of the orange sand, which is always singularly free from any oxidizable matter.

"The microscopic examination corroborates the importance of the lignite grains, and associates them with grains of carnelian, and clear quartz spotted with carnelian as characteristics of the Port Hudson strata, to which group the great beds of gravelly sand with the overlying finer sands are accordingly referred. On the other hand, the same examination shows the vegetable re-

mains in the alluvium to be merely macerated, or slightly carbonized, detecting no other fossils at all. * * * On the whole, as great a thickness as 20 or even 15 feet, of uniform and unquestionably alluvial deposits of today will rarely be seen, even 10 feet being unusual, and from a few inches to 2 or 3 feet the most common range.

"From this point of view, the great sand bed of boring No. 1, at Helena, as well as those lying beneath the unquestioned alluvium of the Choctaw Bar borings, and in No. 1, of Lake Providence reaches (Mayersville), presented a doubtful point, these sands being remarkably uniform in their nature and appearance, not only at different depths in the same locality, but even on comparison of those from different borings. The fact that in all these cases the massive sand beds show both the lignite grains and those of quartz spotted with carnelian, which they have in common, not only with each other, but with the typical "buckshot clay' of known Port Hudson age, of which an authentic sample was fortunately in my possession, is sufficient, in the absence of fossils, to cause them all to be referred to the Port Hudson epoch. It is a curious fact that this buckshot clay, which is so abundant in the backlands of the bottom, happened not to form the surface at any point where borings were made, unless it be at Greenville. Stiff clay soils were in several cases found at the surface, but these were underlaid by the undoubted river alluvium.

"The Greenville boring is unique, in that it was made at a point in the bottom apparently above high water mark, and that coincident with this the red and spotted quartz grains with lignite were found in the sand within a few feet of the surface. No microscopic organisms were found in the surface soil, but even that is unlike the river alluvium. In other words, it seems as if at Greenville the older (Port Hudson) materials were at the surface near the river bank, as some distance back they are on the "buckshot' lands, uncovered by any alluvium. * * *

"In general, conclusions reached as regards the geological history and structure of the great bottom within the limits of the borings in question are therefore these: A trough whose depth exceeds at one point 248 feet below high water mark has been excavated into the tertiary beds originally filling it probably to a height considerably above that mark. This trough has subsequently been filled up to above present high water mark with deposits dating, in their present position, from the period of gradual depression following the deposition of the orange sand,

and during which the orange sand materials were eroded and re-deposited in the trough, or similar materials were brought *de novo* from northern regions. The gravel and coarser sand were, of course, left in the more northerly portion of the trough, while in the southerly one the comparatively slack water produced deposits of sandy loams, fine silt and 'buckshot' clay. (Dr. Hilgard is evidently referring to the Port Hudson strata instead of the 'orange sand,' as he has before shown that the material in the 'trough' contains matter that is foreign to the latter, and common to the former.—T. G. D.)

"As the depression increased, and the slack water advanced up the valley, finer materials, like the sand overlying the gravels, were deposited, and finally the loess and yellow loam now covering the uplands. Upon re-elevation the loam and loess in the middle portion of the trough were washed away; but when the resistant buckshot clays were reached erosion concentrated upon the lines of least resistance, and the river of today was formed. The great alluvial ridge in the axis of the valley shows that while the river has shifted its channel by the formation and cutting off of bends, its general location has roughly remained the same. Where the river has washed away the ancient deposits it has left its alluvium overlying such as remained; but while at many points the alluvium *filling old river beds* must, of course, be of corresponding thickness, viz., from 70 to 100 feet, or perhaps more, alluvium of such thickness has been struck only in boring No. 5, Choctaw Bar, viz., 68.2 feet; the maximum thickness found elsewhere being (in the case of the Hays Landing or Lake Providence No. 3 boring) 56.8 feet, and mostly between 25 and 40 feet. This is in accord with the similarly shallow depths at which the alluvium was found to terminate in the lower delta."

"Notes on Greenville Section, By E. W. Hilgard.

"The Greenville section is somewhat unique both in its collocation and in the materials penetrated. The spot chosen lies above high water mark; and although the material penetrated down to a depth of 22.8 feet, might from its appearance be taken to be alluvium; yet the fact that above 10 feet the silts resemble in color the transition beds between the loess and Port Hudson strata, while below that level lignite grains and carnelian spotted quartz grains are abundant, seems to justify the conclusion that no alluvium at all has been penetrated here, and that older material lies at or near the surface. This is the more credible as the tertiary strata are also here found at an unusually shallow depth, the least at which they have been struck in any of the borings, viz.,

90 feet. There seems, therefore, to exist here a ridge analogous to the 'Dogwood Ridge,' which forms the continuation of Crowleys Ridge, and runs from opposite Helena to the head of Honey Island, diagonally across the Yazoo bottom."

The following extract is from a paper on "The Lafayette Formation," by Mr. W. J. McGee, of the United States Geological Survey. (Report of U. S. Geological Survey for 1890-91, Page 400):

"Most conspicuous and important of the four phases of the Columbia deposits in the Mississippi embayment, by reason of both extent and thickness, is the Port Hudson. It is a vast bed of blue, black, gray or brown laminated clay, commonly clean, though sometimes parted with sand, silt, or fine gravel, and often charged with calcareous or ferruginous nodules. This tenacious clay floors the entire flood plain of the Mississippi from the mouth of the Ohio well toward the gulf shore, sometimes beneath a veneer of modern alluvium, and the main and most of the minor channels of the great river, and the principal tributaries and distributaries as well, are carved within it. It is pre-eminently a low level deposit, seldom rising far above the modern base level, and many of the corn, cotton, cane and rice fields of the vast region represent it.

"These Port Hudson soils are most fertile when intermixed with modern alluvial sands; when not so intermixed the deposit gives rise to a tenacious and heavy soil, which, when charged with small ferruginous or calcareo-ferruginous nodules, is colloquially known as 'buckshot lands.' This phase of the formation lines the broad ancient valley of the Mississippi from Cairo to the gulf. It is well displayed in the area lifted by the New Madrid earthquake—an area complementary to and hard by the sunken tract of Reelfoot Lake, now forming Lake County, Tennessee. Its thickness reaches 400 feet at Greenville and over 600 feet at New Orleans, and it rests unconformably upon the Lafayette and all older deposits of the region."

A paper by Mr. F. H. Newell, of the Division of Hydrography, in the Report of the U. S. Geological Survey for 1898-1899, refers to the geology of the Lower Mississippi as follows (page 352):

"Geologic Structure.

"As bearing upon the general condition of ground waters, and to a less extent upon problems of river control, the follow-

ing paragraphs prepared by Mr. W. J. McGee are inserted, together with a generalized geologic section across the region. Mr. McGee states that there are three uncomformities of much importance in the geologic development of the Lower Mississippi, these being shown in the section, Fig. 133.

'1 Alluvium. Generally a thin veneer only, ranging from 2 to 10 feet in thickness, occasionally absent, elsewhere thickening downward, filling abandoned channels of river or bayous; always thickening also along banks of river and bayous, where it rises in natural levees, usually from 1 to 5 feet in height.

'2. Loess. Best developed along the bluffs overlooking the river bottom; it grades both horizontally and vertically into brown loam; in some cases, especially along the eastern bluff line, it has accumulated in a ridge skirting the bluff scarp, much as the natural levees of alluvium skirt the river banks.

'3. Lower Mississippi blue clay (Port Hudson formation of Hilgard). An estuarian deposit, overlain unconformably by the alluvium; exposed in all cuttings in the river banks at low water, and in all stages of river in the area lifted by the New Madrid earthquake; grades laterally into the brown loam, and is gravelly at depths; where it forms the surface by reason of absence of alluvium it constitutes the 'buckshot lands' of the Lower Mississippi.

'4. Brown loam (of Hilgard). A deposit of slack and probably brackish waters, mounting the bluffs and adjacent highlands to the altitude of from 200 to 500 feet above the river, the material, like that of the loess and a part of the blue clay, being generally calcareous and evidently formed of glacial mud from the Upper Mississippi region; grades laterally and horizontally into loess, and also into the blue clays.

'5. Lafayette formation (Orange sand of earlier literature). A deposit of brown, red or orange gravel and sand, often grading downward into stratified sands containing beds of silicious clay; unconformable to all the underlying formations, and largely eroded before the later formations were deposited.

'6. Tertiary deposits (Grand Gulf, white limestone, lignitic or eolignitic, according to latitude). Marine or brackish water formations of several thousand feet thickness in the aggregate, or several hundred feet at nearly any point in the Lower Mississippi region; they rest unconformably on cretaceous and paleozoic formations toward the borders of the region. The alluvium is recent, the loess, blue clay, and brown loam, are Pleistocine;

the Lafayette is nonfossiliferous, but is indicated to be Pliocene by physical relations; the Grand Gulf is Miocene, and the white limestone and lignite are Eocene.'

"The Pleistocene deposits (loess, blue clay and brown loam) represent at least two periods of accumulation, corresponding with the principal episodes in glaciation of the upper Mississippi region, but the deposits can not be discriminated generally in the field or distinguished in small scale sections; collectively, they correspond with the Columbia formation of Eastern United States in its two divisions."

Having collected all of the accessible literature on this interesting and important study, an effort will now be made to summarize the information, theories and suggestions gleaned therefrom, and to construct a logical system of the geological development of the Mississippi embayment from the glacial epoch to its recent history.

A difficulty presents itself at the outset from a lack of precision and accordance of the various authorities in their expressions regarding the oscillations of the territory embraced in the discussion. That there were such occurrences seems abundantly attested by different characters of evidence, and especially by the discovery of several planes of stump and leaf strata superposed one over the other, in some cases hundreds of feet beneath the present surface.

These bear witness that the several planes where stump and leaf strata are still found in situ once occupied positions of much higher elevation, and were land or marsh surfaces supporting heavy growths of cypress trees, which were successively submerged by subsiding movements and became in turn the resting beds for additional accumulations of sedimentary deposits. The movements of subsidence must have been spasmodic, or at least characterized by periodicity, to have afforded stable conditions for sufficient times to develop the tree growths by which these periods are marked.

An outlined history of the various physiographic mutations that have culminated in the present geologic status of the Mississippi embayment, would seem to take shape about as follows:

At a relatively recent period in the geologic history of the North American continent, a great "ice cap" extended down from polar regions to about the fortieth degree of latitude across the United States. In post tertiary time, by some climatic change there was a rapid melting of the southern margin of the ice cap with a corresponding recession of the ice mass toward the

arctic circle. An enormous volume of water was thus liberated, which flowed southward, carrying with it the "grist from the glacial mill," consisting of sand, gravel, shingle and larger rock fragments. This material was spread broadcast over the land as far south as the margin of the Gulf of Mexico as then existing, mantling the surface of the country to a depth of some 200 feet. The heavier matter found lodgment in the higher latitudes and constitutes the "northern drift;" the finer materials traveled farther south and became the "southern drift," or "orange sand" of Hilgard, called the "Lafayette" by McGee. (Mr. McGee dissents from this view, assigning the "Lafayette" to the Pliocene, while Hilgard and others placed it in post tertiary time. But this question is not important to the present discussion.)

The series of downward and upward movements of the territorial surface which followed the first glacial recession northward, have not been defined with any attempt at clearness or precision, so far as disclosed by accessible geologic literature. The glacial flood, however, at some period of the movement as it poured southward betwen the Ozark mountains on the west and the Appalachian highlands to the eastward, formed a line of depression along the axis of the Mississippi valley where a concentration of flow scoured out the deep and wide trough that constitutes the Mississippi embayment of today. The overlying drift (Lafayette) was swept away, or transposed and rearranged at lower elevations in the excavated trough, probably aiding with the grinding effect of its gravels and sands the eroding action of the water, by which the overlying material was carried out, down to and into the tertiary strata below. Without attempting to follow the various oscillations of the bed of the embayment, it may be said that at a subsequent period of its history this great excavated trough became the receptacle of the "Port Hudson clay," with its intercollated beds of sand and gravel, brought down from the glacial mill by the glacial floods, the materials being assorted as they were laid down in accordance with prevailing conditions that produced more or less rapid movements of the water, with areas of stagnation, in different localities.

a At a later period of the development a continental subsidence brought the more northerly region to a plane of depression below that near the gulf, carrying the body of stagnant water high up into the valley, in which was deposited that vast plane of typical Port Hudson clay which now constitutes by far the greater extent of the surface area known as the Mississippi "delta." A second extension of the ice cap southward brought it down

over the same territory from which it had formerly receded, which was followed later by a second recession northward of the mass of ice, with another liberation of great floods of glacial water. From the latest invasion and retreat of the ice cap there came a stupendous quantity of "rock flour" (McGee) in the form of "brown loam" topped by "loess" or "calcareous silt." This material filled the whole Mississippi and Missouri Valleys, far up into Dakota, and was spread over the adjacent highlands. The last epoch of great mutation was an elevation of this territory by which the whole mass of brown loam and loess was washed out of the valley trough and the surface planed down to the more resistant floor of Port Hudson clay, which still remains uncovered, except partially by the alluvium of the modern river, which constitutes but a small proportion of the present area.

There is left a remnant of the brown loam and loess along the rim of the basin, topping the highlands that margin the ancient embayment and the valley of the Missouri River, generally a narrow fringe of a few miles in width overlying the more ancient formations. The loess bluffs are a conspicuous feature, especially along the "eastern rampart" of the embayment, and far up the Missouri River valley.

The display at Sioux City, Iowa, is particularly striking to the observer, where it presents the form of massive-looking hills rising to some 200 feet above the river bottom, and showing the characteristic features of this unique formation. The Sioux City bluff formation is identical in appearance with the Vicksburg hills. A Vicksburger, seeing the vertical faces of the road cuts in the hills about Sioux City, with the familiar feature of caves excavated into the homogeneous loess mass, might easily fancy himself in the environs of his home town, the similarity being perfect. This same material is conspicuously displayed in the Chickasaw bluffs in Tennessee, along the highlands bordering the Yazoo basin in Mississippi, at Vicksburg, Natchez, Fort Adams, Baton Rouge and intermediate points. At Vicksburg it rests directly upon the Eocene rocks, the lowest of the tertiary strata; but as a rule, the Lafayette immediately underlies the loess.

About the time of the last-named culmination of physiographic changes in the Mississippi embayment the retreating ice cap had ceased to supply glacial water to the Mississippi valley, whatever remnant of flow from that source then liberated being diverted through the chain of Great Lakes into the St. Lawrence River.

The southward flow of glacial water being thus cut off, the present drainage system of the Mississippi valley was gradually developed, carrying only the volume of flow then reduced to the storm waters of its own drainage territory. Thus was born the modern Mississippi River, that has incised a channel for itself down through the Port Hudson strata and into the upper part of the underlying Tertiary, as disclosed by the researches of various geologists in the foregoing pages.

It is certain that the Mississippi River of today has had little to do with building the country that is popularly called the Mississippi Delta, having contributed but a small moiety of the material that forms the Mississippi alluvial plain.

Dr. E. W. Hilgard has pertinently remarked, as before quoted: "The great alluvial ridge in the axis of the valley shows that while the river has shifted its channel by the formation and cutting off of bends, its general location has roughly remained the same." This suggestion must address itself forcefully to the intelligence of all engineers who are conversant with the topography of the region.

The question remaining to be discussed is, how much alluvial material has been in recent geologic time, and is still being, brought into the so-called "alluvial basin" of the Mississippi River, and what disposition has been and is being made of it?

From the observed incapacity of the present river current to transport heavy sediment, such as sand and gravel, of moderate coarseness, for more than short distances at a time, it may be inferred that a limited quantity only of these materials is brought into the basin from extraneous sources, and that this limited quantity so entering has itself been picked up a short distance above, and is soon deposited in place of similar material that has similarly been picked up by caving and scouring in the upper reaches of the river, the last taking the place of other so displaced material a few miles lower down, and so, by a regular progression there is a general down stream movement of this purely local load of sedimentary matter, until the region is reached below Red River, where there is very little caving and scour going on, and consequently an inconsiderable extent of local displacement and redeposition. A logical inference from this premise is, that the same quantity of extraneous heavy matter that enters the river at the head of the basin should be delivered at the lower end of the series into the head of the flat slope division below Red River, and should be projecting the steep slope regimen from above into this lower division of flat slope.

This is incontrovertible, and such process is doubtless going on. But the fact that such a development is inconspicuous to ordinary observation is proof in itself of the smallness of the movement in aggregate results.

There is another class of material that enters the basin from above, which is the finely comminuted particles of silt and clay that from its lightness is susceptible of being carried indefinitely by the current of the river. It seems probable that all of this matter passes throughout the length of the channel and is carried into the gulf or its vicinity, except some portion that is deposited in slack water on the flank of the current and is replaced by other such matter taken up from the caving banks.

That there has been no progressive elevation of the banks of the river themselves is evidenced by the fact that ancient cut-off bends that have for centuries borne the character of lakes, or old river beds, have banks that are now as high and in some cases higher, than the present banks of the Mississippi River.

The conclusion seems to be abundantly sustained that the idea of the levee system being in arrest of a natural process by which the whole expanse of the so-called Mississippi Delta is being built up by alluvial deposits, and that the material thus prevented from such distribution must find lodgment in the bed of the river, may be dismissed as wholely mistaken and chimerical.

Journal of the
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ISSUED QUARTERLY.

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MARCH, 1905.

Mr. F. B. Maltby, United States Superintendent of Dredging, Mississippi River Commission, has resigned his commission and accepted a very important position with the Isthmian Canal Commission. The good wishes of the Society go with Mr. Maltby, although he never became a member of the Society while stationed at Memphis. He favored us with a very exhaustive lecture on the "Bridges Across the Mississippi River." Mr. Maltby has been succeeded by Mr. Wm. Gerig, member of the Memphis Engineering Society, as superintendent of dredging. Mr. Gerig has for a number of years been assistant superintendent of dredging.

The past winter has been one of exceptional severity, and it has had its effect on the Society. It was not possible to get out sufficient members at either the January or February dates to warrant holding a formal meeting. For this reason the paper which was to have been read by Mr. J. M. Heiskell is withheld from publication at this time.

At the meeting of December, 1904, Mr. John A. Fox secured a lecture from Mr. G. A. Ogressek, President of Treasure Gold Mining Co., Ketchican, Alaska. The lecture is printed in this issue, and was thoroughly enjoyed by those who had the pleasure of hearing it. Mr. Ogressek is thoroughly in love with the northern territory as an inviting field for engineers, and predicts a great future for Alaska in other lines, as well as in mining. He very modestly presented the claims of his mining proposition for the consideration of the members.

We do have more than one-half of the eligible men of the city and vicinity among the members of the Memphis Engineering Society. The Executive Board of the Society has officially recognized this and divided a list of a number of the desirable men among several of the members of the Society, with the request that an earnest effort be made to get the applications of such as are named in at an early date. By a concerted effort the membership could be swelled to double our present number by the time of the annual meeting.

Speaking of the annual meeting, which occurs on the second Tuesday of June, the prospects are good for a red letter day on that occasion. Mr. H. G. Fleming, President and Chief Engineer of the Union Railway Co., has signified his willingness to place a special train at the disposal of the Society on that occasion to belt the city and see what the city has to offer in an industrial way. Mr. Wm. Gerig, Superintendent of Dredging, will entertain the Society with a trip to the fleet and a visit to the river improvement works along the Memphis Reach. At the last meeting of the Executive Board a committee of three was appointed to arrange the details of an annual meeting which should incorporate the above features in an outing and business meeting. The members of the committee chosen are: Wm. Gerig, Chairman; J. T. Ferguson and C. C. Pashby. They will be pleased to have such suggestions as the members have to offer.

Through the courtesy of some of our friends we have received substantial donations for the rooms and library of the Society. Mr. W. D. Edwards, M. E., Randolph Building, Memphis, has secured a set of catalogues from B. F. Sturtevant Co., Boston, Mass., consisting of Catalogue No. 103, the Sturtevant Engine; No. 117, Sturtevant Electric Motors, Generators and Generating Sets; No. 118, Steam Hot Blast Apparatus; No. 119, Sturtevant Exhaust Heads and Steam Traps; No. 120, the Sturtevant Economizer; No. 96, Steel Plate Fans; No. 99, Steel Pressure Blowers; No. 100, "Monogram" Blowers and Exhausters; No. 101, Steel Planing Mill Exhausters; No. 116, the Sturtevant Disc and Propeller Fans; a treatise on Ventilation and Heating, and Mechanical Draft, a practical treatise by Walter G. Snow of the Engineering Staff or B. F. Sturtevant Co.

Mr. Boggs, Resident Engineer of the Virginia Bridge and Iron Co., Randolph Building, Memphis, Tenn., has procured for the Society two framed photographs of steel plate girder bridges erected by his company.

Mr. W. W. Fischer, of John A. Denie's Sons, has procured for the Society a framed photograph of the works of the Blackmer & Post Pipe Co., St. Louis, Mo.

In riding about the streets of Memphis one of the most striking features of the visible improvement is the considerable stretch of asphalt pavement which was laid two years ago by the Memphis Asphalt & Paving Company. This company was organized in Memphis with Memphis capital, and the streets built in Memphis constitute its maiden effort in the laying of asphalt pavements. Last season the company laid several miles at Shreveport, La., with the same success that has accompanied their efforts in Memphis. A visit to their plant at the northeast corner of Manassas street and the L. & N. R. R. will repay one well for the time spent. Just at this time the plant is not in operation, but the yards and stock houses are filled with materials which are to be used in paving Second street north from Union street.

Their plant is a portable one, built on two cars. One contains the drums for heating sand and stone, steam engine air pump, fans for forced draft and elevating and conveying machinery. The other contains the furnaces and kettles for cooking the asphaltic cement, air blast being used for agitation. Between the two is located the measuring and weighing machinery which gauges the ingredients before dumping them into the mixing worms. The mixing worms discharge directly into the wagons drawn between the two cars.

At a later date the Journal will contain a paper on the general subject of asphalt paving operations in Memphis, in which some account will be given of the materials used and the problems encountered. For the present, suffice it to say that the Memphis Asphalt & Paving Co. are to be credited in a large measure for the favor in which this kind of pavement is held in the city today.

QUARTZ MINING IN ALASKA.

Read at Meeting December, 1904, by Mr. G. A. Ogressek, President Treasure Gold Mining Co., Ketchikan, Alaska.

Mining, especially quartz mining, is as yet in its infancy in Alaska. Between the years of 1896 and 1900 there were only, or almost exclusively, placer mining, with the exception of the Alaska Commercial Company's quartz mines at Unga, on Unga Island, one of Unalaska's Shumagen Island's group, where a twenty-stamp mill had been in operation, and the famed Treadwell on Douglas Island.

Alaska is indeed a wonderful, fascinating land—a land of uncomprehensible mineral wealth—a land of grandeur, of beauty of undreamed possibilities, comprising a territory of about 2,000 miles lying between the heaving Pacific and the Polar Sea, due north and south, and 1,600 miles across, due east and west, traversed by hundreds of swift, icy streams and two immense rivers; the noble Yukon, having its source in Northwestern Canada, Yukon Territory, emptying into Behring Sea below St. Michael, has a length of over 2,200 miles, and the Kuskokwin, which winds its corrugated body from Western Tanana, a branch of the Yukon, southward into Bristol Bay, north of Aleutian Islands, a chain of islands extending from the mouth of Cook's Inlet, Gulf of Alaska, sooouthwest toward Japan, whose surfaces are barren, bleak, treeless, unhospitable, studded with extinct and active volcanoes, the most prominent of them being Akutan, on Akutan Island, 4,784 feet high, having two vents in its crater pouring forth white and yellow clouds. It is the guardian of Unimak Pass, the steamship route from San Francisco and Seattle to Nome, the greatest placer mining territory in Alaska. Makushin, another active volcano, is west of Dutch Harbor and has a height of some 5,280 feet; its belching crater surrounded by eternal snows.

Alaska, as far as known, has the greatest, most imposing glaciers in the world; the Muir, Eastern Alaska, west of Juneau, is still "flowing" at a lively rate into the sea in Icy Bay. It traverses a territory of over eighty miles northward to the southern range of mountains hemming in the Klohena River

west of Skaguay, casting a few icy tentacles over the mountains of Lynn Canal and back among the sky-kissing peaks of Mount Fairweather range in the west.

The country in that land of golden dreams is extremely rugged and unhospitable, yet extremely fascinating. There are immense ranges of ice and snow-capped mountains whose grandeur is incomparable, and in whose bosom slumbers a wealth of precious metals beyond human comprehension. The ranges stretching themselves between the famous Copper River and Cook's Inlet, east and west, north of Valdez Inlet, Prince William Sound, are mostly slate; dipping northward at an agle of about 27 degrees, and are comparatively barren, there being thus far discovered but one vein carrying copper; but the range at the head and east of Copper River, composed of granite and slate, 350 miles north of Port Valdez, has untold riches of gold and copper, both placer and in ledges, but thus far only the placers being worked, since it is impossible to transport machinery necessary for quartz mining that distance over a rough country. The Government had engineers in the Copper River Valley surveying and men clearing a way—a wagon road to connect the sea with the Tanana country, which is now ablaze with excitement, on account of the fabulous rich gold discoveries made there last summer, and there is no doubt but that the wagon road thus mapped and cleared will become the road bed of a railroad in the near future, which the Havemeyers' interests in New York will build, since they own copper property in that territory worth millions of dollars.

Alaska has thus far four railways; the first one constructed runs between Skaguay, head of Lynn Canal, and White Horse Rapids, a head branch of the Yukon River, and is a most glorious achievement of the engineering skill, a triumph of human brains over almost impregnable obstacles of nature. A trip in a comfortable modern railway coach over that wonderful road impresses one with almost a divine reverence for a science, an art, a superhuman intelligence and energy of the modern engineer, which has had the audacity to hew out of the vertical cliffs its roadbed and flung the tiny steel threads over hair-raising, dizzy trestles, spanning the gray gaps of frowning glacier-ribbed, vertical, granite cliffs, whose bases a thousand feet below are washed by the foaming waters of the Skaguay River, tumbling towards its mother's bosom, the sea. This road leaves the sea at Skaguay,

climbs slowly up along those narrow granite shelves, and finally dives into a tunnel and emerges upon a level stretch of land over 5,000 feet high.

The second road built in Alaska was the famous *Wild Goose* Railroad in *Nome,* five miles long, between the Behring Sea and the gold-stuffed Anvil Creek, but by what authority the owners named that chip of a road a *Wild Goose,* or any sort of a goose, is a marvel to me. A *drunken crow* would be about the right title for its cussedness. Why, a passenger had to hold on to ropes stretched along the flat car to keep himself from being dumped overboard into a comfortable pool of cool water, or into a lake of blue, ill-smelling mud, as it went merrily pitching and rolling along, like a vessel at sea. Every trip of that train required a gang of track-lifters to follow its five-mile-per-hour flight with boards and poles to fish out of the mud and water sections of the track which the ten-ton engine squeezed out of sight.

The third road is now being constructed between Solomon City, on Behring Sea, thirty-five miles east of Nome, and Council City, the new metropolis of a great placer mining district on Fish River, north of Golovin Bay.

The fourth road is now under construction also, beginning at Resurrection Bay, Kenia Peninsula, southwestern entrance to Prince William Sound, whose destination is Tanana River and mining territory. Said road, the *Alaska Central,* will cover, when completed, 484 miles, and will pass through the greatest and richest valley in Alaska, whose soil is extremely fertile and produces abundantly of wheat, rye, oats, luxuriant hay, and all sorts of vegetables, and will in a few years blossom with homesteads by the thousands.

MINES.

The greatest quartz mine on earth thus far is the Treadwell mine on Douglas Island, opposite Juneau, 910 miles north of Seattle, Wash. It is not really a mine, but a quarry. There are ledges of ore over thirty feet between walls; in fact, that whole section of the island seems to be one mass of low-grade ore whose average value is about $2.30 per ton, and yet the mine makes a net yearly earning of $600,000, and has paid thus far about $4,000,000 in dividends, in spite of the enormous amounts the company expends yearly in blocking out at different levels mil-

lions of tons of ore. There are over fifteen miles of rail trackage in the various tunnels, and the management is such that the ore is mined, hauled and milled at a cost of but $1.23 per ton, thus netting the company about one dollar on each ton mined and crushed. For years now there have been eight hundred and fifty 1,000-pound stamps crushing 3,500 tons of ore per diem. About one hundred and fifty days per year the mills are run by water power only, the balance of the time steam being employed, on account of lack of water and on account of cold, which is quite severe there. The famous *Glory Hole* of the Treadwell mine is a wonder. It is funnel-shaped, about 200 feet in diameter on top and tapering to a narrow space, where there is a sort of a trap door permitting the ore to drop through and into the ore cars running in the tunnel beneath. A 24-car train can thus be loaded in the space of 24 minutes. The mining in that glory hole is all accomplished by suspended compressed air 2 1-2-inch drills.

There are also great mines in Berner's Bay, sixty miles above Douglas Island, especially the Noel mine, which sold 51 per cent. of its interest to the ex-superintendent of the Treadwell, McDonald, and his friends, for $2,000,000 during last season. Said mine, when equipped with new machinery, will yield, according to present indications, over $1,000,000 to its owners yearly. All work on that mine is done by stoping—that is, overhead work, at a cost of about $3.50 per ton. Present ore body averages over $40.00 per ton.

At Windom Bay and Sundum, forty-eight miles south of Juneau, are also great properties. The Sundum Chief has been working over eight years, and is following a lead clear through the mountain into Stephen's Straits, using the old tunnel of the Bald Eagle beneath it for drainage and ventilation purposes. They have several shafts sunk down to base of mountain from the upper levels, and are drifting thence north and south on large bodies of ore. The cost of mining and milling is $4.00 per ton; average value of ore about $7.00 per ton.

On Taku Inlet, back of Juneau, there is also a ten-stamp mill pounding away on $6.00-a-ton ore and the owners garner from its operation to pay for all development work. Work there is by stoping—overhead mining.

In Silver Bow Basin, back of and above Juneau, both placer and quartz mining is being prosecuted on a large scale and at a great profit. The Ebner mine is well equipped with modern

stamp mills, using mostly water power. They have immense bodies of good eight-dollar-per-ton ore, which is being mined by stoping. The formation is coarse granite, dipping northeast in layers almost horizontal. The mountains are over 4,000 feet in height, the walls steep, almost vertical in places. There are ledges of quarts, running due north and south and east and west. The Sheep Creek ledge's trend is eastward and will intersect those of the Ebner mines. The Sheep Creek ledge or vein is very unsatisfactory, it being "kidneyed," and has the unpleasant habit of "dying out,' or disappearing for long periods, yet in general the mine pays comfortable dividends. The value of the ore is about $10.00 a ton; cost of mining, on an average, $4.00 per ton.

Between Sundum and Ketchikan, or say, Prince of Wales Island, a distance of 280 miles, there is as yet no producing mine, thoughthere are many fine prospects.

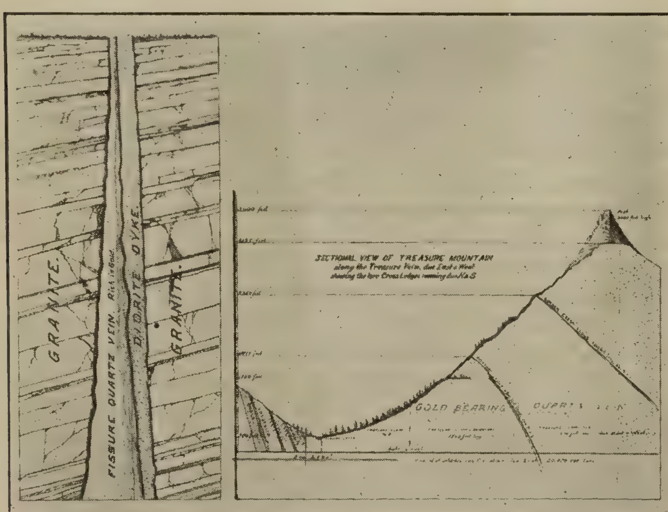
KETCHIKAN MINING DISTRICT.

Contains a large territory of the richest mineral land in Southeastern Alaska. It embraces the whole of the Prince of Wales Island, Revillagigido and Gravina Islands, a territory of 145 miles due north and south, and over 100 miles due east and west, and boasts with perfect confidence of the greatest and richest mineral deposit in the land. Revillagigido Island, upon which that hustling town of Ketchikan is situated, has a variegated formation of granite shale, some slate, and extensive dykes of schist, and diorites. The general trend of these dykes is southwest. One of those schist formations, or dykes, crosses the mountain back and north of Ketchikan, dips into the sea, the Tongas Narrows, and emerges on the shore of Gravina Island, six miles southwest of that town, where a rich strike of gold has been discovered in it, and the same is now being worked at a great profit. This valuable dyke or schist lode cuts the country's rock formation at an angle of 45 degrees, dipping westward at an angle of about 90 degrees.

PRINCE OF WALES ISLAND.

This island is the largest in Alaska, being 145 miles due north and south and about 35 miles across due east and west. Its southern end comes within a short distance of the boundary line between the Alaskan territory and that of Canada at Dixon's

entrance. It is 650 miles from Seattle, Washington, in a northwestern direction. Its topography is rugged, mountainous, with lofty peaks near its center, at two points it being almost cut in twain, by Kasaan Bay in the east and Klavak Inlet in the west, as well as twenty-five miles further south by Cholmondeley Sound and Copper Mount Bay. Its rocky formation varies in different sections. For seventy miles north of Kasaan Bay the formation is coarse granite, basalt, lime, shales, slates, but has no valuable minerals, so far as known, beyond Tolstoy Bay; but southward as far as Moira Sound, a distance of thirty miles, there are several mineral belts of great magnitude, containing fabulous wealth in gold and copper. The richest of it is north and south of Kasaan Bay, an offshoot of Clarence Straits. On the north side, on Kasaan peninsula, in granitic formation, there are ore bodies from six to fifty feet in width of magnetic iron, carrying a large percentage of copper sulphurets, whose value ranges from 2 to 30 per cent. in copper, and some gold. These ore deposits have a northwestern course, dipping northward at various angles. Only development work had thus far been done upon them until the Hadley Copper Mining and Smelting Company erected a 400-ton



Sectional View of Treasure Mountain along the Treasure Vein, due east and west; two Cross Ledges running due north and south.

daily capacity smelter last August, when the mining was begun in earnest, and have thus far mined over 20,000 tons of ore,

which is now stored in two 10,000-ton ore bins. The whole peninsula seems to be traversed by immense copper-bearing ledges, and no doubt there are millions of tons of rich ore of easy access. The smelter is of the modern improved pattern and will produce the ore at a cost of $3.00 per ton or less, which will be a great boon to the district, and will be the cause of great mining activity.

PAYING, OR MINE-MAKING VEINS.

(See Illustration.)

In mining there are four known or recognized veins, ledges or lodes.

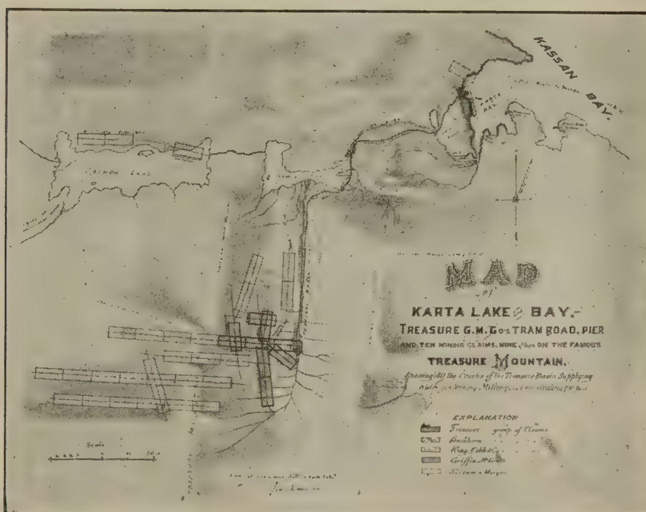
Gash vein is a vein or rift in the earth's crust, V-shaped, caused by a cleavage due to shrinkage of the earth's surface, widest at surface, narrowing downward. Any mineral found therein finds its way into it from the surface. They never make a safe or paying mine, as their depth is too shallow.

Blanket vein is a vein of mineralized ore filling in spaces between the layers of any formation of rock, generally of shales, slates, lime rock, but seldom in granite. These ore sheets or bunches are often of great richness, but unreliable as to expanse and difficult and costly to mine. They never form an extensive or a safe mine.

Contact vein is a deposit of ore between two different formations of rock, say granite on one side and more likely slate on the other. These veins follow the layers of the country's rock formation and are generally found to dip at angles of 30 to 65 degrees. The country rock is apt to be broken along such veins, requiring timbering of drifts, shafts or raises, and the cost of mining is generally about $4.00 per ton.

Fissure veins are the only positive mine-making veins whose depths are immeasurable and whose widths increase as they go downward. A fissure vein is produced by a cleavage of the earth's crust from the inner to the outer surface, and if these veins carry any value at all, they are the richest, easiest to work and inexhaustible. If such a vein cross-cuts the formation, it is in that case an absolute proof of a paying mine, and should the country rock through which it has forced its way be granite, the mine then is an assured bonanza, since these veins often, in fact, invariably, widen out from a foot or so at the surface to hundreds of feet at depths of 3 to 4,000 feet, and thus become real quarries and can be followed for thousands of

feet downward as long as the increasing heat of the rock permits the drill to eat its way into it, and should by some fortunate chance such a vein or ledge be intersected by another of like formation, the ore body there would be of great extent and immensely rich in gold. There are instances where such intersections of two valuable ledges netted hundreds of thousands of dollars of almost pure gold.



Illustrates Method of Locating Claims.

LOCATING MINING CLAIMS.

A placer mining claim contains twenty acres of land, 660x 1,320 feet. Location is made in an oblong square in any desired direction. Creek claims have the creek's general course for their center line, with 330 feet on each side. Side lines must be straight and parallel. Boundaries of a claim of that sort must be marked with four posts, one at each corner, and upon one of them must be placed the location notice, describing the lay of the claim. The sizes of these claims differ according to the richness of the ground. In Klondike, for instance, they are only 100 x 100 feet; in Atlin, British Columbia, 200 x 200 feet,

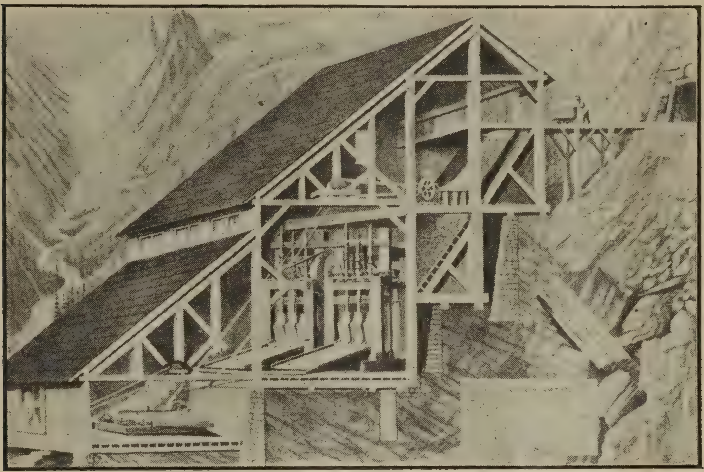
Quartz claims are located along the course of a quartz or other mineral bearing vein, ledge or hole, and consists of 600 x 1,500 feet.

MODE OF STAKING A QUARTZ CLAIM.

Upon discovery of a ledge or lode the prospector erects a 4 x 4-inch post upon or near the "find," upon which he indites a notice of location by merely stating that he claims 600 x 1,500 feet of mineral land. This is termed a thirty days' notice to all newcomers to keep away 1,500 feet from that post. This privilege is given the discoverer that he may have time and opportunity to permanently locate and define the course of his vein or lode, which claim he can swing in any direction of the compass it may be necessary to cover the located vein or ledge. In thirty days, therefore, he must perfect his location by defining the course of the lead with stakes or blazes on convenient trees, indicating them as *center* line of "Treasure Claim," and marking the corners and both center ends with posts. Upon the original discovery post he then places the final notice, claiming so many feet on one and so many feet on the other side of said discovery post. For instance, 500 feet east from this post upon which the notice is placed, called the east center post; thence 300 feet south to a post marked S. E. corner; thence 1,500 feet west to a post marked S. W. corner; thence 300 feet north to a post marked west center end; thence 300 feet north to a post marked N. W. corner; thence 1,500 feet east to a post marked N. E. corner; thence south to east center end, thus giving an oblong square with seven permanent posts, a duplicate copy of which is transmitted to the recorder of the mining district with all information added thereto which would or could lead anyone to its location. On said notice being recorded, the described claim or claims become his property by right of location, and t ohold same the owner has to perform $100.00 worth of labor upon each twenty-acre claim every year until he purchases same from the government. A failure to perform this required work, the property reverts back to the government and is open for a re-location by any one desiring to do so, and in such an event of re-location, he acquires also all the improvements of any shape, form or value erected upon said lapsed and re-located property.

Application for a patent of land claimed, the applicant must have the ground surveyed and permanent monuments at corners erected. The application must be accompanied by the surveyor's description of claims and field notes of the survey, with maps, etc., and a copy of all be given to the nearest paper published at least once a week, for ninety days' publication. At the end

of ninety days, if no cross-claims are filed, the Land Office at Sitka confirms his claim and title, and issues the patent for said mineral land, which is perpetual. Cost of such mining land is $5.00 per acre.



Quartz Gold Stamp Mill.

EXTRACTION OF GOLD.

All gold mines of the world rely upon the old style of stamp mills to do the required work. The illustration here given of one of these mills is plain and easy of comprehension. The structure in which it is erected usually has four floors leaning against a hill or mountain. On the upper floor is the receiving floor for the ore brought out of the mine. There it is dumped to the floor below, the ore crusher floor, where the rock is crushed into one-half or one-fourth-inch size. It drops then into an ore bin beneath it, from whence it is fed by an automatic ore feeder to the stamps. The stamps in this instance are six, three in each battery, driven by one cam shaft. Each stamp weighs one thousand pounds and has an individual mortar into which it drops, a distance of about six inches, upon a chilled steel die covered with rock, thus pulverizing it. The number of drops per minute are usually from ninety to one hundred and ten. Each stamp is doing its own rough and fine crushing to any fineness desired. The whole operation is that of a mortar and pestle on a large scale.

The mortar blocks are firmly bolted to a cross beam imbedded in concrete upon solid rock with open faces on all four sides, covered with perforated sheet metal or brass wire screen of twenty to forty mesh; that is, with twenty to forty holes to the inch, through which the pulverized ore, mixed with water, called "pulp," passes down upon the aprons, 5 x 8 sheet of heavy copper silvered and covered with mercury, termed the amalgamating plates, by which all the particles of free gold contained in the flowing pulp are extracted and held as amalgam, while the balance of the mineral bearing gold and silver passing over said plates is extracted by the concentrating tables on lower floor, and then smelted, and by those means the precious metals recovered. Concentration of gold bearing mineral is accomplished by the concentrating table as follows: The table being 5 x 10 or 12 feet, having an endless belt, slowly moving at a gentle incline toward the head of the table, and passing over a large roller or drum, turns dwonward through a trough of water, the receptacle for concentrates. The pulp coming from the batteries, passing down the aprons, reaches this table through iron pipes and flows evenly upon the moving belt, usually made of rubber. The lighter particles, such as rock, flow off down the ascending surface of the belt, while the metallic particles adhering to the said belt are carried along, and detached while the belt is passing through the tank beneath the table. Usually three-fourths of the gold is in these concentrates, which is recovered in the smelter. A stamp gold mill saves about 90 per cent. and a smelter 98 per cent. of the gold values of ore treated.

TREASURE MINING COMPANY'S CLAIMS.

This company owns nine 600 x 1,500-feet mineral claims situated on the eastern slope of the famous Treasure Mountain on Prince of Wales Island, four miles from tidewater, accessible at an easy grade by a rail tram road. These nine claims are located on four veins or ledges, two of which are proven to be true fissure veins, assuring them a great and paying mine. These claims are so located that all their ore can be handled through one tunnel; in fact, all the ore of the whole mountain.

These ledges carry rich values in gold and silver in the shape of iron and copper pyrites, black sulphurets of iron, galena, black tellurides, sylvanite and free gold. The tunnel so far driven along the strike or course of the main or Treasure vein has

an average gold value of $15.00 per ton of ore, and the said tunnel is within three hundred feet of the point where the Treasure vein is crossed or intersected by the Consort vein, running due north and south, where in all probability a great and extremely rich body of ore will be found, worth perhaps many hundreds of thousands of dollars. There are feasible reasons for such an assumption. First, the crossing vein or ledge following the mountain's slope absorbs more or less of rain and snow water, which naturally follows the walls downward, dissolving in its course all the free gold and depositing same lower down, at the intersection of the Treasure vein, in cavities formed by oxidization of iron and copper pyrites in the form of nuggets, thread and sheet gold. The intersection of these two ledges once reached, the mine is an established fact whose value can then be readily calculated by the size and value of their first ore chute, of which the company has five on their property. From said intersection work can be carried on by drifts along the crossing vein north and south, and uprises made above the tunnel; all mining will be done by stoping or overhead work for at least twenty years, since the company has over 5,000,000 tons of ore above the lower, or main, tunnel.

This company has every facility for cheap, economical mining, having ample water for motive power and other necessary purposes at all seasons of the year. The mill can be operated at a low cost. By lifting the whole of Treasure Creek, flowing through the basin, *fifty feet* above its present bed with a 4 x 6 2,000-feet-long flume, they can secure all the power needed for a fifty-stamp mill by the use of a six-foot Pelton water wheel. The ore will be transmitted from the tunnel to the mill down a 35-degree incline by means of two one-ton ore cars upon three-rail gravity road, the full car drawing the empty one up the incline to the starting point. The tunnels, road and mill will be lighted with arc and incandescent electric lights, the dynamos being driven by a Pelton water motor. The mill will be erected directly below the tunnel on Treasure Creek, which will be connected with the sea, four miles distant, with a railroad.

The Treasure Mining Company is indeed fortunate in having such facilities for mining and milling of their ores; since all their mining work will be done by stoping, or overhead work, the mine will be self-draining. Furthermore, all the ore so mined will be handled by gravity, and thus eliminate the necessity of those troublesome, expensive and profit-eating inconveniences, hoisting and pumping machinery, and can therefore

safely figure the cost of extracting the precious metals at about $1.50 per ton of rock, while the value of ore treated will probably exceed $15.00 per ton, and a mill having a 200-ton daily capacity ought to net the company from $2,000 to $5,000 per day.

View of Treasure Mountain, Showing Veins of Ore.

TREASURE MOUNTAIN.

This extraordinary hump of granite is indeed an enigma to the mining engnieer, and the minerals, gist. Its length is four miles due east and west, and is the cross-bar in the shape of a capital T of an eight-mile range of mountains terminating in the west in a group of semi-circular sky-scraping granite peaks over 7,000 feet high. This remarakble "hump" is 3,600 feet high, its formation having a northerly trend and a westerly dip of about 28 degrees. Its formation is intact, undisturbed, unlike the surrounding country, which is all broken up and faulted. That this mountain is a receptacle of incomprehensible wealth is indicated by the eight fissures cleaving it across from east to west and north to south, and is, according to some English experts, a veritable treasure vault; they computed its metallic value thus: Having 45,000 feet of ledges, averaging same at three feet, gives 135,000 linear feet of gold-bearing quartz; computing the depth of these veins as being only 4,000 feet, we have 640,000,000 feet of ore, nearly 50,000,000 tons, averaging its value as *only* $10.00 per ton, we have the probable amount of gold in

this mountain of about $500,000,000, but as the ledges will average more than three feet and more than 2,500 feet below the sea level as here figured, the amount of wealth will be far above the $500,000,000 mark.

Road building in Prince of Wales Island is quite a serious problem. The land is rock, soilless, and is merely covered by moss, therefore the building of a roadbed is difficult, but the Treasure Company has solved the problem. They will merely fell trees in parallel rows, block them up to the required level, and lay the ties directly upon them, thus erecting a good, substantial road answering all purposes, at a low cost and great saving of time. Its cost will be about $2,800 per mile. It will cross Karta River over a bridge erected upon two ballasted rock cribs. Karta Bay, the road's terminal, is a safe, sheltered, open harbor, where the company owns wharf and warehouse site, and is of sufficient depth for the largest steamers plying Alaskan waters.

Alaska is becoming daily a more and more profitable field for the mining man, the enterprising engineer and the investor. It is a land of brightest prospects, where energy and pluck are bound to win the golden crown of success.

TRADE PUBLICATIONS.

Since the December issue of the Journal appeared the Secretary has made use of a postal card to request copies of the trade publications noticed in the weekly engineering periodicals which seemed to possess especial interest to the members of the Memphis Engineering Society, and the requests have been uniformly well responded to. As a consequence, the Society is accumulating the nucleus of a first-class trade publication library. The recent additions are:

Bulletin No. 6 of the Coffin Valve Co., of Neponset (suburb of Boston), Mass. Devoted to sluice gates and operating mechanisms.

A neat little folder from the Berger Manufacturing Co., Canton, O., entitled, "Ye Olden Time Charcoal Iron." A sample of tin plate accompanies the folder.

A catalogue of the Ludlow Valves and Hydrants from the Pittsburg Manufacturing Co., of Pittsburg, Pa.

A catalogue of the Walrath gas and gasoline engines, from the Marinette Gas Engine Co., Chicago Heights, Ill.

A catalogue containing considerable amount of technical data on ice making and description of the machinery, by the Featherstone Foundry and Machine Co., Chicago, Ill.

A sample of the invisible hinge from the Suss Invisible Hinge Co., No. 150 Nassau St., New York.

A pamphlet entitled, "Graphite as a Lubricant," and two samples of flake graphite from the Joseph Dixon Crucible Co., Jersey City, N. J. This company is represented in Memphis by Lee Brothers.

The DeLaval Steam Turbine Co., of Trenton, N. J., sends catalogues "A" and "B" and Bulletins No. 2, on D. C. Dynamos; No. 3, on A. C. Dynamos; No. 6 on Blower Sets; No. 8, on Train Lighting Sets; No. 9, on record Tests of DeLaval Pumps and circular of publications and line of manufacture.

Vulcanite Portland Cement Co. sends catalogue giving list of users of this cement, and many illustrations of important works into which it has entered. This cement was one of those tested by Mr. Paquin, member Memphis Engineering Society, in preparing his paper which appeared in the September issue of the Journal.

From Geo. N. Saegmuller, Washington, we have his Solar Ephemeris for 1905. This is mailed annually to engineers requesting it.

From the Railroad Supply Co., Chicago and New York we have catalogue No. 5 of the signal and electric department, describing highway crossing signals, block signals and supplies.

The National Bridge Co., of Indianapolis, Ind., sends a Manual of Design for Luten Reinforced Arches, by the president of the company, Daniel B. Luten. The manual presents the designs of several very flat reinforced concrete arches, with formulas.

From the Sullivan Machinery Co., Chicago, Ill., we have Bulletin No. 48-B, on Machinery for Under-Cutting Coal in Room and Pillar Mines; No. 51, on Excavation of Rock by Machinery; No. 49, on Diamond Drills for Prospecting; No. 53, on Modern Practice in Air Compression. These bulletins seem to have been prepared with the object of enlisting permanent interest in this firm's machinery.

From Toch Brothers, 468-472 W. Broadway, New York, we have a pamphlet on "Chemistry of Paints and Raw Material;" also "Permanent Protection of Steel and Iron," and booklet on "Check to Dampness." The first two of these are reprints of technical papers by Maximilian Toch.

The Jeffrey Manufacturing Co., Columbus, Ohio, have sent Bulletin "A," descriptive of a novel coal and ashes distribution plant. The bulletin contains a list of the company's special catalogues.

The Wile Power Gas Co., Rochester, N. Y., have sent their catalogues "A" and "B." The former deals with the uses and cost of producing gas, and the latter with gas producers.

Folder No. 25 of the United Iron Works, 32 Fremont St., San Francisco, Cal., describes the Eclipse Pumps, designed for irrigation, reclamation and general pumping service.

Catalogue "A" of the Prindle Pump and Engineering Co., No. 95 Liberty St., New York, N. Y., describes Standard House Tank Pumps connected to D. C. motors and designed to automatically maintain proper water level in house tanks.

The Rider Ericsson Engine Co., 35 Warren St., New York, sends a catalogue of hot air pumping engines for domestic supply.

Fairbanks, Morse & Co., Cincinnati, Ohio, have sent several folders illustrating pumps, motors and gas and gasoline engines.

A catalogue of the Weber Gas and Gasoline Engine Co. illustrates the Weber Suction Gas Producers and the Weber Gas Engines. Gives a table of comparisons of cost of different fuels for steam, oil and gas engines and current for electric motors.

The Marsh Bridge Co., Des Moines, Ia., sends a catalogue showing bridges constructed by them of considerable interest.

A catalogue of Buckeye Engines built by the Buckeye Engine Co., Salem, Ohio, describes the engines built by this company in sizes from 15 to 8,000-horse power, and contains some pages of information upon engineering science.

The Morse Chain Co., Trumansburg, N. Y., have sent their catalogue No. 7, describing the Morse Rocker Joint, a silent running flexible gearing, and suggesting many applications for same, and a pamphlet entitled, "Opinion of an Expert."

The Clayton Air Compressor Works, 114-118 Liberty St., New York, have sent Bulletin No. C-201, illustrating the main features of Clayton compressors and vacuum pumps. Some of the varied uses of compressed air are mentioned.

Catalogue No. 31 of the A. S. Cameron Steam Pump Works, foot of East Twenty-Third St., New York, is intended to give to prospective purchasers a clear idea of the types and sizes of pumps built by this company. The catalogue also contains much valuable information.

The Abbe Engineering Co., 220 Broadway, New York, sends catalogue of Pebble Mill specialties for fine grinding and thorough mixing, pressure blowers and vacuum pumps.

DISCUSSION

Of Paper by A. Miller Todd, U. S. Asst. Engr., on Effect of Short Line Levees Across Narrow Necks On the Mississippi River,

—BY—

MAJ. T. G. DABNEY,

Chief Engineer Yazoo-Mississippi Delta Levee District.

Mr. C. C. Pashby, Secretary Memphis Engineering Society, Memphis, Tenn.:

Dear Sir—After a protracted absence from my usual haunts, your invitation to take a part in the discussion of Mr. A. Miller Todd's paper ,entitled "Effect of Short Line Levees Across Narrow Necks on the Mississippi River" comes to me so late that I find the field already fully occupied by a number of very interesting papers contributed by several able members of the Society.

There is little room left for me to do more than submit a few comments.

There are some facts in relation to the physical phenomena of nature's processes the truth of which appears obvious as soon as presented for consideration. A case in point is this: Imagine the channel of the Mississippi River uniformly filled with flowing water just up to the tops of ideal banks with none escaping therefrom. Here we have what may be considered an ideal flood slope, which would be normal to such conditions. Now imagine these banks raised, either by natural or artificial agency, up to the top of the highest flood. Then we should have a flood plane which should logically be parallel to the bank full plane and normal to the supposed conditions. This ideal flood plane should approach nearer to uniformity of slope than any other that is imaginable.

If, therefore, it were practicable to be done, economically and otherwise, it would be best to maintain two lines of levees on opposite sides of the river, about parallel to each other and located along the immediate banks of the stream. And departure

from the above ideal arrangement of levee lines must result in abnormalities of flood slopes, the degree of which must, of course, depend upon the extent of such departure combined with local conditions.

Cut-offs.

Where a short line of levee is built across the base of a peninsula there must result a disturbance of normal flood slope proportioned to the relative distances around the bend of river channel and across the base of peninsula, and to the relative volume of water flowing across.

Where a succession of bends are so treated on both sides of the river, as presented in the locality between Arkansas City and Greenville, made prominent in this discussion, there we have a cumulative and exaggerated effect. There is an analogy between the conditions here created by the shortening of the levee lines and those that should result from a series of actual cut-offs of the channel of the river within the territory under consideration, the effect being modified in something like the proportionate volumes of water traversing the shortened passage in the two cases.

The immediate effect of a cut-off is to lower the flood plane at the head of the cut and to raise it at the foot. There is no rule known to the writer by which to determine in any particular case the relative lowering above and raising below of the surface elevations. But it may be stated that the raising below must equal the lowering above, plus the bend resistance presented before the cut-off is made, the latter factor varying in each individual case. The effects resulting from the passage of flood water across peninsulas, as compared with cut-off effects, should be modified by the smaller volume of water passing over the shortened distance, together with frictional resistance of rough ground and obstacles to be passed. The volume of water would of course be increased, and the resistance correspondingly lessened, for a higher flood as compared with a lower one.

Observations taken on the ground during the passage of a flood would seem to be the only safe basis upon which to predicate relative flood elevations and modified levee grades.

It would appear to be a logical sequence, however, that the lowering of flood elevations and grade lines above the peninsula should in some measure compensate for the increase below.

Spur Levees.

With the location of levees now generally prevailing, on shortened lines across river bends, the nearest approach attainable to the establishment of normal flood slopes approximating uniformity, is to be found in the construction of spur levees from the main line to the points of peninsulas, as recommended by Mr. Todd.

There can be no doubt about the desirableness of such a system, the only question being one of economics. The result of Mr. Todd's tentative examination of the comparative cost of a system of spur levees and a readjustment of grades on the main lines to met local aberrations of flood elevations, is promising; but there seems to be room to doubt that such a favorable showing can be realized in all situations. Still, if the spur levee system can be established at a cost not much in excess of the additional enlargement required without such a system, the resultant advantages would justify the cost.

Location of Spur Levees.

A spur levee located along the axis of a peninsula, having its junction with the main line at a point about midway between the upper and lower sides of the "neck," must create a "ponding" of water along the upper side of the spur proportionate to the extent of the slope of the high water plane across the neck when unobstructed by the spur. This must create a local "head" of water near the outer end of the spur, with a concentration of current energy in the flow around the end. A spur so located should terminate in a curve of easy radius extending around the point of the peninsula to the bank below the point.

The ideal location for a spur is that the point of diversion from the main levee shall be near the river bank on the upper side of the peninsular and the alignment of the spur shall conform to the bank, thence down to the point. Practically this location should be approached as nearly as bank conditions and economic considerations might justify. In any case the spur should be extended around the point and terminate near the bank on the lower side, with easy curvature approaching the terminal.

Effect of Spur Levees on Caving Banks and Cut-Offs.

There seems to be no reason to suppose that the rush of a portion of the flood volume across a peninsula has any effect

towards increasing the rate of caving of the river bank on the upper side.

On the contrary, the arrest of this flow by a spur levee, increasing the flood elevation above, and thus increasing the current energy that is exerted against the bank, should logically have a tendency to increase the caving effect as a result of the spur levee, but probably to a negligible degree.

It is also a fallacy to suppose that the flow of flood water across a peninsula tends to produce a cut-off of the river channel, except under very special conditions. There are many situations where such flow has proceded for many years without any manifestation of such tendency. In the history of cut-offs on the Mississippi River, superficial excavations when made for the purpose of producing cut-offs have failed of such results until the neck of the peninsular has become so attenuated from caving on both sides that the cut-off would have occurred without such effects to promote it. On the other hand, the presence of a spur levee along the axis of a peninsula may hasten the progress of a threatened cut-off if the spur should give way at the point near the base of the peninsula, thus precipitating a crevasse, with the attendant deeply scoured excavation and tendency toward gorging along the line of crevasse flow. The passage of an unobstructed flow of water across a peninsula has but little scouring tendency. But any considerable obstruction that may be placed in the path of the flowing water results in the formation of holes of more or less magnitude and depth, which might under some circumstances contribute to the making of a cut-off. In the year 1874, when the neck of the peninsular opposite Vicksburg had been narrowed to 1,200 feet, a very large sycamore log became stranded on the "neck." This became a tumbling dam for the overflow water and resulted in scouring out a large and deep hole below the log. This, however, probably did not contribute to the cut-off that was precipitated two years later, which resulted from a caving through of the river bank, the rate of caving having been about 600 feet a year for several years preceding.

In the earlier history of the Mississippi River, before the Federal Government assumed control of channel regulation, efforts were made from time to time at many points to hasten the occurrence of cut-offs, to meet the wishes of certain of the landowners and the navigators. These efforts always took the form of canals excavated across the necks of the peninsulas,

and always failed of the desired results except in some cases where the catastrophe was on the point of being precipitated by natural agency.

For many years such a canal existed across the bend near Waterproof, La., and a similar one across the Davis bend peninsula below Vicksburg.

The Mississippi River made these cut-offs in its own good time without the aid of the canals, by caving its way through the necks of land. Many persons suppose that the Vicksburg cut-off was occasioned by "Grant's canal," which was cut during the Civil War, but the cut-off occurred at a point some two miles from the "canal," which is there at this day, still intact.

The true way to promote a cut-off is not to provide for an easy flow of the water, but to place obstructions in its way and thus provoke scouring action, resulting in deep excavations.

But as cut-offs are no longer considered to be desirable achievements in the Mississippi River, a further discussion of the question is without profit.

T. G. DABNEY.

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INDUSTRIAL LEAGUE

I. F. PETERS, Commissioner.

11 EXCHANGE BUILDING.

FACTS.

Volume of business, 1903, $300,000,000.

Memphis is the largest Hardwood-producing Lumber Market in the world.

The largest Inland Cotton Market in the world.

Produces more Cotton Seed Products than any city in the world.

Has the largest Artesian Water System in the world.

Twenty Banks and three Trust Companies. Capital and surplus, $6,000,000. Deposits, $26,000,000.

The lowest death rate of any city of 100,000 or over in the United States.

One hundred and twenty-three Churches.

Sixty-five Schools, Colleges and Seminaries.

Eight hundred and Fifty Manufacturing Enterprises.

Five Theatres. One Park Theatre.

Two Race Tracks, (trotting and running)

One hundred and twenty-five miles of Electric Street Railway.

Twenty-six Local Steamboat Packets.

Two hundred and fifty miles of turnpike.

One thousand Acres in Public Parks.

Memphis is the best sewered city in the world.

Count the Railroads. The Mississippi River is equal to as many more.

Real Estate Transfers:

1902	$4,259,290
1903	6,174,040
Five Months 1904	3,397,830

Based upon the above five months the total for this year will show a net increase over 1903 of over $2,000,000.

Building improvements, city and suburbs:

1902	$2,532,000
1903	3,265,235
Five Months 1904	2,148,543
Increase over same period 1903	767,974

Post Office Receipts:

1901	$247,292.94
1902	294.052.57
1903	342.120.71
Six months 1904	189,445.67
Increase over same period 1903 18 per cent. or	28,745,30

Number of cars handled in and out of Memphis:

1903	202,400

Clearing House Receipts for five years ending January 1, 1904.

1901	$154,482,935.75
1902	179.199,939.22
1903	214,009,558.12
Six Months 1904	131,291,933.56
Increase over same period 1903 30 per cent, or	31,481,482.25

Population.

1901	141,360
1902	150,223
1903	159,326
1904	165.457

These figures include about 25,000 inhabitants just beyond the city limits, not enumerated in the United States Census.